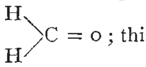
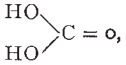
stream of chlorine slowly allowed to pass through it. The very volatile methylene chloride distils over, as it is formed, into a condenser which is strongly cooled by a freezing mixture. In order to prepare the new gas, the methylene chloride is placed in a tube of Bohemian glass along with the proper quantity of pure silver fluoride, and the tube sealed before the blowpipe. It is then heated for half an hour to 180°. In an actual experiment 1·7 gram of methylene chloride and 5·08 grams of anhydrous silver fluoride, specially purified by the method described by Gore, were employed. Upon opening the tube, a great rush of gas occurs, which on collection and analysis is found to consist of methylene fluoride. The density of the gas compared with air was found to be 1·82, which agrees very closely with the theoretical density, 1·81, required for the formula CH_2F_2. Alcoholic potash is found to absorb it completely. Hence, in order to obtain a measure of the amount of carbon contained in the gas, a measured volume was absorbed in alcoholic potash and then treated with acetic acid and potassium permanganate. The alcoholic potash appears to convert it into formaldehyde,  $H_2C=O$; this is oxidized by the potassium permanganate to carbonic acid,  $(HO)_2C=O$, and the acetic acid consequently liberates a volume of carbon dioxide equal to the volume of methylene fluoride experimented upon. This affords a ready mode of demonstrating at the same time the principal properties of the gas and its composition as regards the amount of carbon contained in it. Experiments are now in progress from which it is hoped some knowledge will be gained concerning its physiological action, which it will be interesting to compare with that described by MM. Regnault and Villejean in case of methylene chloride. In a recent communication by M. Moissan upon carbon tetrafluoride, CF_4, an account of which was given in NATURE (May 15, p. 67), it was recommended that metallic tubes should always be employed in these reactions with silver fluoride, inasmuch as fluorides of carbon attack glass with production of carbon dioxide and silicon tetrafluoride; for instance, $CF_4 + SiO_2 = CO_2 + SiF_4$. But M. Chabrié finds that if hard Bohemian glass is used, the product contains only mere traces of the two gaseous impurities mentioned, and, as glass is so much more convenient to manipulate, considers it advisable to use it. The methylene fluoride prepared in the above manner was quite sufficiently pure for all practical purposes.

THE additions to the Zoological Society's Gardens during the past week include a Common Marmoset (*Hapale jacchus*) from South-east Brazil, presented by Mr. Percy Standish; a Malbrouck Monkey (*Cercopithecus cynosurus* ♂) from the Upper Shire, two Grand Galagos (*Galago crassicaudata*) from Mandala, Shire Highland, East Africa, presented by Mr. John W. Moir; two Common Marmosets (*Hapale jacchus*) from South-east Brazil, presented by Mr. W. Norbury; a Common Fox (*Canis vulpes* ♂), British, presented by Mr. Atkins; a Great Crested Grebe (*Podiceps cristatus*), British, presented by Mr. T. E. Gunn; two Green Lizards (*Lacerta viridis*), three Wall Lizards (*Lacerta muralis*), a Dark-Green Snake (*Zamenis atrovirens*), four Common Snakes (*Tropidonotus natrix*), four Marbled Newts (*Molge marmorata*), an Edible Frog (*Rana esculenta*) from the South of France, presented by the Rev. F. W. Haines; eighteen Young Green Turtles (*Chelone viridis*) from Ascension Island, presented by Captain Robinson; a Silvery Gibbon (*Hylobates leuciscus*) from Java, deposited; a Philippine Paradoxure (*Paradoxurus philippensis*) from Zebu Island, Philippines, three Japanese Teal (*Querquedula formosa* ♂ ♀ ♀) from North-east Asia, purchased; an Angora Goat (*Capra hircus*, var., ♂), two Yellow-legged Herring Gulls (*Larus cachinnans*) bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

OBJECTS FOR THE SPECTROSCOPE.

Sidereal Time at Greenwich at 10 p.m. on June 19 = 15h. 52m. 18s.

Name.	Mag.	Colour.	R.A. 1890.	Decl. 1890.
			h. m. s.	° ′
(1) G.C. 4244	—	Bluish.	16 43 56	+47 48
(2) 367 Birm.	6	Red.	15 59 21	+47 32
(3) α Serpentis	2	Yellow.	15 38 54	+ 6 46
(4) α Coronæ	2	Bluish-white.	15 30 0	+27 5
(5) U Cassiopeiæ... ...	Var.	Red.	0 40 11	+47 39

Remarks.

(1) The spectrum of this nebula, according to an observation made by Dr. Huggins in 1866, is a continuous one, but this result does not appear to accord with Smyth's description of it as "a fine planetary nebula, . . . large, round, and of a lucid pale blue hue." The G.C. description of it is: "Very bright, large; round; disk with faint, possibly resolvable, border." I know of no later observation of the spectrum than that referred to, but it is important that it should be confirmed, as the colour alone would lead to the supposition that there is something in addition to continuous spectrum. It is indeed possible that we have here a case of a nebula intermediate in condensation between those which give a spectrum of bright lines, and those which give a so-called "continuous" spectrum. In any case the apparent discrepancy between colour and spectrum should be investigated, for it is generally understood that planetary nebulæ with a bluish colour give bright lines.

(2) Dunér describes the spectrum of this star as a magnificent one of Group II. "All the bands 2–10, 6 included, and possibly 1, are visible. They are of extraordinary width and entirely black. The spectrum is totally discontinuous." The usual more detailed observations should be made.

(3) This star has a spectrum generally described as similar to the solar spectrum. The usual more detailed observations, as to whether the star is increasing or decreasing in temperature, are required.

(4) The spectrum of this star is a well-marked one of Group IV., but so far we have no information as to the temperature of the star relatively to others with almost similar spectra.

(5) The spectrum of this variable has not been recorded. The range of variation is from 8·5 to 14 in about 260 days. There will be a maximum about June 20.

A. FOWLER.

OBSERVATIONS OF METEORS.—The May number of the *Monthly Notices* of the Royal Astronomical Society contains a catalogue of 918 radiant-points of meteors observed by Mr. Denning at Bristol since 1873, together with a mass of information pertaining to their determination. The total number of meteors seen from 1873 to 1889 was 12,083, and the paths of 9177 of these were registered. The following table shows the horary rate of apparition of the meteors during the various months of the year:—

January ...	6·5	July	11·3
February ...	4·9	August	11·3
March	6·6	September ...	10·3
April	6·6	October... ...	11·8
May	5·2	November ...	11·3
June	4·9	December ..	8·9

The mean horary rate of apparition is therefore 8·3. This is less than would be observed from a place where there is no interference with the light and smoke of a large town, some observations made by Mr. Denning in a different locality increasing the mean horary number to 11·4.

The observations were almost equally distributed between the morning hours, and were usually made between the third and first quarter of the moon, because a bright sky is very effective in obliterating meteor-showers, and therefore moonlight meteors are commonly rare.

As to the relative numbers which appear during the night, the maximum appears to be attained between 2 and 3 a.m., when the rate is nearly double that observed in the early hours of the evening. Two or three meteors have frequently been noticed to appear at nearly the same time and from the same radiant, the probable explanation in such cases being that the

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two objects originally formed one mass, which suffered disruption owing to the vicissitudes encountered in planetary space.

The average length of path of all the meteors registered is 10°·9. The average height of either fireballs or shooting-stars has been computed, from thirty-eight instances, to be—

Beginning height ... 71·1 miles.
End height ... ... 48·2 ,,

From a comparison of a large number of other similar results, the following general average has been deduced :—

Beginning height ... 76·4 miles (683 meteors).
End height ... ... 50·8 ,, (736 ,,).

If fireballs and shooting-stars are separated, the usual heights of disappearance are: fireballs, 30 miles; shooting-stars, 54 miles. A considerable amount of information as to the radiant-points, stationary and otherwise, has been brought together; and, with the catalogue, they render Mr. Denning's paper one of a very important character.

Brooks's Comet (*a* 1890).—The following ephemeris has been computed by Dr. Bidschof (*Astr. Nach.*, 2970), and is in continuation of that previously given (vol. xlii. p. 138). The elements have been found from observations at Cambridge, March 21, and Vienna, April 18 and May 24 :—

T = 1890 June 1·5360 Berlin Mean Time.

$$\left.\begin{array}{l}\omega = 68^\circ\ 54'\ 39''{\cdot}9\\ \Omega = 320\ 20\ 32{\cdot}2\\ \iota = 120\ 33\ \ 5{\cdot}4\end{array}\right\}\text{Mean Eq. }1890{\cdot}0.$$

$\log q = 0{\cdot}280524$

Ephemeris for Berlin Midnight.

1890.	R.A.	Decl.	Brightness.	1890.	R.A.	Decl.	Brightness.
	h. m. s.	° ′			h. m. s.	° ′	
June 21	15 59 27	+65 19·5		July 12	13 48 18	+55 30·9	2·10
,, 22	49 35	65 5·3	3·08	,, 13	45 11	54 58·1	
,, 23	40 4	64 48·6		,, 14	42 15	54 25·6	
,, 24	30 56	64 29·4		,, 15	39 29	53 53·3	
,, 25	22 13	64 8·1		,, 16	36 53	53 21·2	1·93
,, 26	13 55	63 44·9	2·88	,, 17	34 27	52 49·5	
,, 27	6 0	63 20·0		,, 18	32 9	52 18·1	
,, 28	14 58 29	62 53·6		,, 19	29 59	51 47·0	
,, 29	51 22	62 25·9		,, 20	27 56	51 16·3	1·77
,, 30	44 38	61 57·1	2·68	,, 21	26 0	50 45·9	
July 1	38 16	61 27·3		,, 22	24 11	50 15·9	
,, 2	32 15	60 56·7		,, 23	22 29	49 46·3	
,, 3	26 35	60 25·4		,, 24	20 52	49 17·0	1·63
,, 4	21 14	59 53·6	2·48	,, 25	19 21	48 48·1	
,, 5	16 12	59 21·4		,, 26	17 56	48 19·7	
,, 6	11 27	58 48·8		,, 27	16 36	47 51·7	
,, 7	6 59	58 15·9		,, 28	15 21	47 24·1	1·50
,, 8	2 46	57 42·9	2·29	,, 29	14 10	46 56·9	
,, 9	13 58 48	57 9·9		,, 30	13 4	46 30·1	
,, 10	55 6	56 36·8		,, 31	12 1	46 3·8	
,, 11	51 36	56 3·8		Aug. 1	11 1	45 37·9	1·38

Photograph of Brooks's Comet (*a* 1890).—A photograph of this comet was obtained at Algiers on May 22 by M. Ch. Trépied (*Comptes rendus*, June 9, No. 23). Two hours' exposure was found necessary.

ASTRONOMICAL TELESCOPES.[1]

BEFORE speaking of the enormous instruments of the present day, with their various forms and complicated machinery, it will be well to give some little time to a consideration of the principles involved in the construction of the telescope, the manner in which it assists the eye to perceive distant objects, and in a brief and general way to the construction and action of the eye as far it affects the use of the telescope, all as a help to consider in which way we may hope to still further increase our sense of vision.

I will ask you to bear with me when I mention some things that are very well known, but which if brought to mind may render the subject much more easy. Within pretty narrow limits the principles involved in the construction of the telescope are the same whatever form it ultimately assumes. I will take as an illustration the telescope before me, which has served for the finder to a large astronomical telescope, and of which it is really a model. On examination we find that it has, in common with all refracting telescopes, a large lens at one end and several smaller ones at the other; the number of these small lenses varies according to the purpose for which we use the telescope. Taking out this large lens we find that it is made of two pieces of glass; but as this has been done for a purpose to be presently explained which does not affect the principle, we will disregard this, and consider it only as a simple convex lens, to the more important properties of which I wish first of all particularly to draw your attention, leaving the construction of telescopes to be dealt with later on.

Stated shortly, such a lens has the power of refracting or bending the rays of light that fall upon it: after they have passed through the lens the course they take is altered; if we allow the light from a star to fall upon the lens, the whole of the parallel rays coming from the star on to the front surface are brought by this bending action to a point at some constant distance behind, and can be seen as a point of light by placing there a flat screen of any kind that will intercept the light. For all distant objects the distance at which the crossing of the rays takes place is the same. It entirely depends on the substance of the lens and the curvature we give to the surfaces, and not at all upon the aperture or width of the lens. The brightness only of the picture of the star, depends upon the size of the lens, as that determines the amount of light it gathers together. If, instead of one star we have three or four stars together, we will find that this lens will deal with the light from each star just as it did with the light of the first one, and just in proportion to the distance they are apart in the sky, so will the pictures we see of them be apart on our screen. So if we let the light from the moon fall on our lens, all the light from the various parts of the moon's surface will act like the separate stars, and produce a picture of the whole moon (in the photographic camera the lens produces in this manner a picture of objects in front of it which we see on the ground glass). When we attempt to get pictures of near objects that do not send rays of light that are parallel we find that as the rays of light from them do not fall on the lens at the same angle to the axis the picture is formed further away from the lens. The nearer the object whose picture we wish to throw upon the screen is to the lens, the further the screen must be moved. If we try this experiment we will find, when we have the object at the same distance as the screen, the picture is then of the same size as the object, and the distance of the screen from the lens is twice that which we have found as the focal length; on bringing the object still nearer the lens, we find we must move the screen further and further away, until when the object is at the focus the picture is formed at an infinite distance away, or, what is more to our purpose, the rays of light from an object at the focus of a convex lens go away through the lens parallel, exactly as we have seen such parallel rays falling on the glass come to a focus, so that our diagram answers equally well whatever the direction of the rays; and this holds good in other cases where we take the effect of reflection as well as refraction.

We can also produce pictures by means of bright concave surfaces acting by reflection on the light falling upon them. Such a mirror or concave reflecting surface as I have here will behave exactly as the lens, excepting, of course, that it will form the picture in front instead of behind. The bending of the rays in the case of the convex lens is convergent, or towards the axis, for all parallel rays; if we use the reverse form of lens—that is, one thicker at the edge than in the middle—we find the reverse effect on the parallel rays; they will now be divergent, or bend away from the axis; and so with reflecting surfaces if we make the concavity of our mirror less and less, till it ceases and we have a plane, we will get no effect on the parallel rays of light except a change of direction after reflection. If we go beyond this and make the surface convex we then will have practically the same effect on the reflected rays as that given to the refracted ray by the concave glass lens.

As regards the size of the picture produced by lenses or mirrors of different focal length, the picture is larger just as the focal length is greater, and the angular dimension is converted into a linear one on the screen in due proportion. Now, as we

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[1] Discourse delivered at the Royal Institution on Friday, May 30, 1890, by Mr. A. A. Common.

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